

Clusterization Processes in Supercooled Water + Glycerol Solutions

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The cluster concept of water structure is developed. The conclusions about the existence of crystal-like and gas-like clusters in normal and supercooled water are based on the careful analysis of thermodynamic properties, experimental data on acoustics and molecular light scattering, and computer simulations. The hierarchies of the spatial scales and the characteristic times are established. The kinetic equation describing the time evolution of clusters is proposed.

This approach allows us to explain self-consistently the temperature anomalies of the density, the compressibility and the heat capacities of water as well as the temperature behavior of its self-diffusion coefficient, the shear viscosity and the thermal conductivity. The description of the Landau-Placzek ratio, the frequency dispersion of the dielectric permittivity, the incoherent neutron scattering and others are also successful.

The interaction of clusters with admixture molecules of glycerol is analyzed. It was shown that these molecules can penetrate only inside the gas-like clusters, essentially changing their structure. As a consequence, concentration fluctuations in water + glycerol solution become long-rang correlated. The manifestations of this phenomenon in PCS experiments and NMR are discussed.

The influence of clusterization on nucleation processes is investigated. It was shown that the clusterization magnifies the stability of supercooled states of water. The nature of the high-density and the low-density water is discussed.